Manual Cervical Traction and Trunk Stabilization Cause Significant Changes in Upper and Lower Esophageal Sphincter: A Randomized Trial

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Abstract

Objectives: Dysfunctions in the lower esophageal sphincter (LES) and the upper esophageal sphincter (UES) levels can occur owing to poor muscle coordination, contraction, or relaxation. Such condition can possibly be addressed by functional rehabilitation. The aim of this study was to measure pressure changes in the UES and LES at rest and during routine rehabilitation techniques, that is, cervical manual traction and trunk stabilization maneuver.

Methods: This study was conducted in a University Hospital Gastrointestinal Endoscopy Center. Cervical manual traction and a trunk stabilization maneuver were performed in a convenient group of 54 adult patients with gastroesophageal reflux disease. High-resolution manometry was used to measure pressure changes in the LES and UES at rest and during manual cervical traction and trunk stabilization maneuver.

Results: Average initial resting UES pressure was 90.91 mmHg. A significant decrease was identified during both cervical traction (average UES pressure = 42.13 mmHg, $P < .001$) and trunk stabilization maneuver (average UES pressure = 62.74 mmHg, $P = .002$). The average initial resting LES pressure was 14.31 mmHg. A significant increase in LES pressure was identified both during cervical traction (average LES pressure = 21.39 mmHg, $P < .001$) and during the trunk stabilization maneuver, (average pressure = 24.09 mmHg, $P < .001$).

Conclusion: Cervical traction and trunk stabilization maneuvers can be used to decrease pressure in the UES and increase LES pressure in patients with gastroesophageal reflux disease. (J Manipulative Physiol Ther 2021;44;344-351)

Key Indexing Terms: *Gastroesophageal Reflux; Lower Esophageal Sphincter; Upper Esophageal Sphincter; Esophageal Motility Disorders; Diaphragm; Musculoskeletal Manipulations*

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Introduction

Gastroesophageal reflux disease (GERD) affects about a quarter of the adult population in the United States and Europe.[1] GERD significantly affects quality of life[2] and is responsible for the greatest gastrointestinal (GI) disease treatment cost in the United States.[3] In 2004, drugs prescribed for dyspepsia in the United Kingdom cost 7% of the primary care prescribing budget.[4] Similarly common as GERD is dysphagia, occurring in 8% to 22% of persons over the age of 50, and even more frequently in older populations.[5] As a result, functional GI disorders are frequently researched with the aim to decrease the prevalence of the disorders, improve quality of life, and reduce financial burdens associated with diagnosis and treatment. Although there is a risk of side effects with medication,[6] rehabilitation and manual therapy that are proven to be effective[7-11] may offer few side effects while showing positive health economic implications.[12]

Within the GI tract, the esophagus is a common location for disorders to manifest, specifically in the 2 sphincters located within the esophagus. The upper esophageal sphincter (UES) consists of the cricopharyngeus muscle circular fibers, which are closed at rest, preventing esophageal air intake during inhalation. The UES permits both antegrade and retrograde flow of material during swallowing, belching, and vomiting,[13] thus forming an important anatomic and functional landmark.[14] The lower esophageal sphincter (LES), together with the crural part of the diaphragm, is the main anti-reflux barrier, protecting the esophagus from regurgitating stomach contents.

Apart from structural disorders such as neoplasms, Zenker's diverticulum, or thyroid disorders,[15] the UES may present with many types of dysfunction. The UES can fail to relax, which may be a motor disorder caused by a medullary lesion[16] or a Parkinson's disease symptom.[17] The UES opening can also become diminished, primarily owing to weakness or insufficient pharyngeal propulsion. Both conditions may be associated with neurologic disorders such as generalized myopathy, amyotrophic lateral sclerosis, Parkinson's disease, and other neuromyogenic conditions.[13] UES incompetence may result in esophagopharyngeal regurgitation.[13] The LES can also be structurally affected by cancer, ulcers, or inflammation; however, functional incompetence resulting in GERD is by far the most frequent problem.[3]

Other than structural or neurologic causes, dysfunctions in both the UES and LES levels can still occur owing to poor muscle coordination, contraction, or relaxation. When patients complain of digestive problems in the absence of structural changes, functional GI disorders are conditions frequently seen in gastroenterology practice.[18] Often, no organic, anatomic, histological, biochemical, ultrasonographic, endoscopic, or even histochemical changes can be identified. This suggests the cause could be an impaired regulation, which may be reflected in the sphincter function, or a change in motility and tone. Impaired motility combined with increased visceral sensitivity, psychosocial conditions, and central nervous dysregulation are considered to be important etiopathogenic factors. A biopsychosocial model as a basis for understanding and treating these disorders has been proposed.[18]

The UES and LES are partially formed by skeletal muscles,[19] and because certain maneuvers like changing body position[20-22] can alter UES or LES pressure, the authors speculate that impairments at the sphincter level can be improved by rehabilitation techniques. Existing literature reports the positive effects adequate physical activity,[23] breathing exercises[7,10,11] and osteopathic visceral treatment[9] can have on GERD symptoms. However, the exact mechanism of the rehabilitation treatment effect has not been reported. To create an optimal rehabilitation strategy and improve clinical outcomes, it is important to first understand how certain techniques change the UES and LES pressures. Therefore, the purpose of this study was to examine the effect of manual cervical traction and a trunk stabilization maneuver, 2 common rehabilitation procedures aimed to improve UES pressure (UESP) and LES pressure (LESP) in patients diagnosed with GERD. The 2 rehabilitation techniques were chosen based on long-lasting positive clinical experience of the team working with patients with GERD and dysphagia supported by studies demonstrating that trunk and neck positioning are important for a normal feeding and swallowing process.[24-27] We hypothesized that both procedures would relax UES and activate the LES in a sample of patients with GERD.

Methods

Participants

Fifty-seven participants, 29 male and 28 female, aged 20 to 66 years (weight 47 kg to 110 kg, height 152 cm to 196 cm, body mass index 18.6-39.0) were recruited to participate in this study. Participants were included if they presented with typical GERD symptoms, that is, acid regurgitation and heartburn with or without other frequent symptoms such as chronic dry cough, halitosis, epigastric pain, dyspepsia, or nausea. All testing procedures were thoroughly explained to the participants with a detailed description of the assessments. Any participant with a history of previous gastroesophageal surgery, concomitant disease, other chronic diseases affecting esophageal motility (neuromuscular disease, achalasia, diffuse esophageal spasm, scleroderma) or structural pathology (pharyngeal pouch, diverticulum), and massive hiatus hernia were excluded from the study. A total of 3 participants were excluded from the study owing to missing data on 1 or more of the measures (Fig. 1). Written informed consent was obtained from each participant, and this study was approved by Institutional Ethical Board, University Hospital Motol, Prague, Czech Republic. All authors of this article had access to the study data and reviewed and approved the final manuscript. This study was registered as a clinical trial (registration number NCT03871426) and followed the Consolidated Standards of Reporting Trials checklist (Fig. 1).

High-Resolution Manometry (HRM) Measurement and Intervention

Upon arrival at the hospital endoscopy center, participants were randomly assigned in an every-other fashion to undergo cervical traction first, followed by the trunk stabilization maneuver, or vice versa. Routine HRM procedures using a solar GI manometry system were performed by the same skilled gastroenterology specialist well trained for over a decade in HRM performance and assessment. The HRM assessment was performed according to the same procedures described by Bitnar et al.[20] A water-perfused HRM catheter was applied transnasally with the patient in a sitting position. The UES and LES were identified, and the catheter was fixed. Then the participant was instructed to lie supine and perform a series of 10 swallows of 5 mL of water. First, initial resting pressures were recorded in the

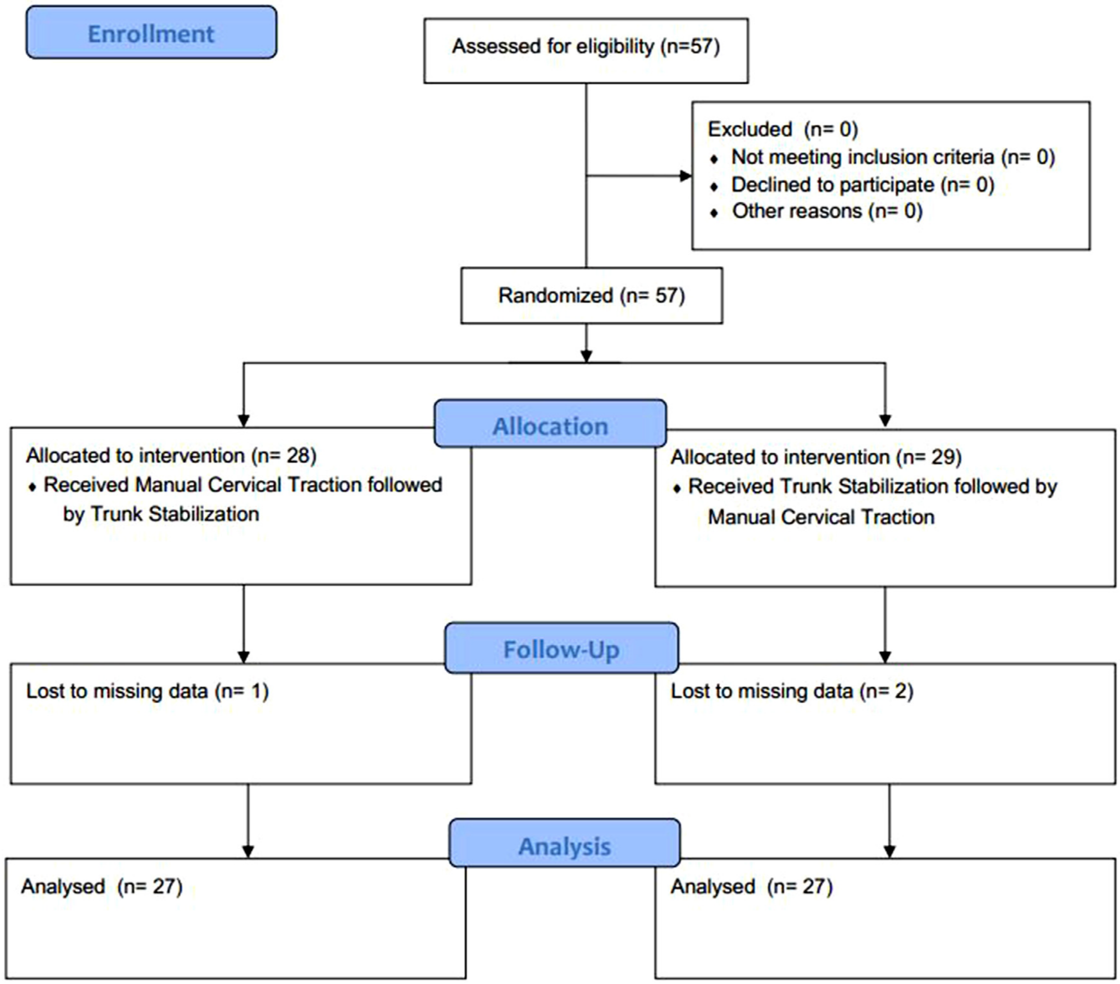

Fig 1. *A study flowchart according to the CONSORT.* CONSORT, *Consolidated Standards Of Reporting Trials.*

UES and LES at rest. Both maneuvers were performed within 1 measurement session. The cervical traction or trunk stabilization maneuver was performed, depending on which order the participant was assigned, and then UESP and LESP were monitored to return to within ±5 mmHg of the initial resting pressure, and the second maneuver was performed, recording the UESP and LESP values again. All manual maneuvers were performed by the same licensed physiotherapist, with 15 years of experience. The manual cervical traction maneuver (Fig 2A) and the trunk stabilization maneuver (Fig 2B) were performed according to Dynamic Neuromuscular Stabilization principles published previously in detail.[28,29] To assure that manual pressure applied on the trunk did not affect the HRM catheter, that is, to rule out manual pressure increases the LES after placing the therapist's hand on top of the patient's chest, it was observed that LES pressures did not change. Only then the trunk stabilization maneuver was performed, bringing the chest in a caudal position while not pushing the patient's chest toward the table. With every participant, each maneuver was performed only once for a period of approximately 30 seconds. After both measurements, the patient performed 1 more swallow of 5 mL of water and returned to the seated position, and the catheter was removed. All participants tolerated the measurement procedure well. The manometric data were analyzed using MMS solar GI HRM software.

Statistical Analyses

Descriptive statistics were calculated for each measure. Paired-samples *t* tests were used to compare esophageal pressure in both the UES and LES at rest and after both manual procedures, with Bonferroni corrections applied where necessary. Power analysis, using G*Power 3.1, indicated an 80% chance of detecting a medium effect size of 0.5 in 34 participants with statistical significance determined a priori at $P < .05$ (2-tailed). Cohen's d effect sizes were calculated for differences between pressures as the mean difference between groups divided by the pooled

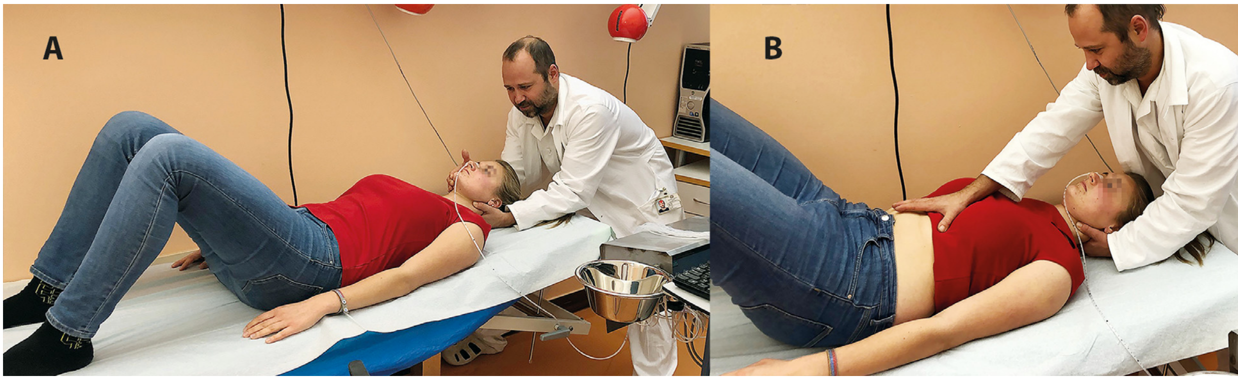

Fig 2. *A, Cervical traction. The participant rests supine with feet supported on the table. The therapist performs cervical traction while centrating the neck according DNS principles, keeping the cervical spine neutral to avoid any flexion or extension of the neck. B, Trunk stabilization maneuver. Using the right hand, the therapist stabilizes participant's neck in the neutral position, avoiding extension, while bringing the chest into the caudal, neutral position with the left hand.*

standard deviation. Effect sizes were interpreted as very small (<0.2), small (0.2-0.5), medium (0.5-0.8), or large (>0.8).[30] Data analyses were conducted using Statgraphics Centurion XV, version 15.2.06. Statistical significance was determined a priori 2-tailed $P < 0.05$.

Results

Table 1 presents descriptive statistics of the sample (n = 54). Fifty-four participants completed the study. Participants were randomized to either first complete the manual traction followed by trunk stabilization (n = 28 of participants) or to complete the trunk stabilization followed by manual traction (n= 29 of participants). There were 10 outliers in the data as assessed by box plot values greater than 1.5 times the interquartile range; however, they remained in the data analysis, as the observation of large variances in pressure is not unusual for individuals with GERD, and because there were no differences in statistical outcomes. Paired-samples *t* tests indicated the mean UESP was significantly lower with cervical traction compared to the initial resting pressure (mean initial = 90.91 ± 68.99 mmHg vs mean traction = 42.13 ± 33.27 mmHg; $P \leq .001$, Cohen's d = 0.88). Upper esophageal sphincter was also significantly lower during the trunk stabilization maneuver compared to the initial resting pressure (mean initial = 90.91 ± 68.99 mmHg vs mean stabilization = 62.74 ± 69.55 mmHg; $P = .002$, Cohen's d = 0.43). Fig. 3 illustrates the results. The mean LESP was significantly higher during cervical traction compared to the initial resting pressure (mean initial = 14.31 ± 11.53 vs mean traction = 21.39 ± 13.42 mmHg; $P < .001$, Cohen's d = 0.52). Lower esophageal sphincter pressure was also significantly higher during the trunk stabilization maneuver compared to the initial resting pressure (mean initial = 14.31 ± 11.53 vs mean stabilization = 24.09 ± 12.72 mmHg; $P < .001$, Cohen's d = 0.98). Fig. 3 illustrates the results.

Discussion

The results of this study confirm a significant influence of routine manual rehabilitation techniques, that is, cervical traction and trunk stabilization maneuver on UESP and

Table 1. *Pressure Changes in the UES and LES (mmHg) During Manual Cervical Traction and Trunk Stabilization Interventions (Mean [SD])*

n = 54 DNS Maneuver	Measure	Initial Resting Pressure	Post Maneuver Pressure	95% CI	Mean Difference	Effect Size	*P* Value
Cervical traction	UES	90.91 (68.99)	42.13 (33.27)	(33.63-63.93)	48.78	0.88	<.001[a]
	LES	14.31 (11.53)	21.39 (13.42)	(−10.81 to −3.34	7.08	0.52	<.001[a]
Trunk stabilization	UES	90.91 (68.99)	62.74 (69.55)	(10.40-45.93)	28.17	0.43	.002[a]
	LES	14.31 (11.53)	24.09 (12.72)	(−12.5 to −7.06)	9.78	0.98	<.001[a]

Values are mmHg. Effect size = calculated Cohen's d.
CI, confidence interval; *DNS*, dynamic neuromuscular stabilization; *LES*, lower esophageal sphincter; *SD*, standard deviation; *UES*, upper esophageal sphincter.
[a] Statistically significantly difference observed (Bonferroni correction, $P < .025$).

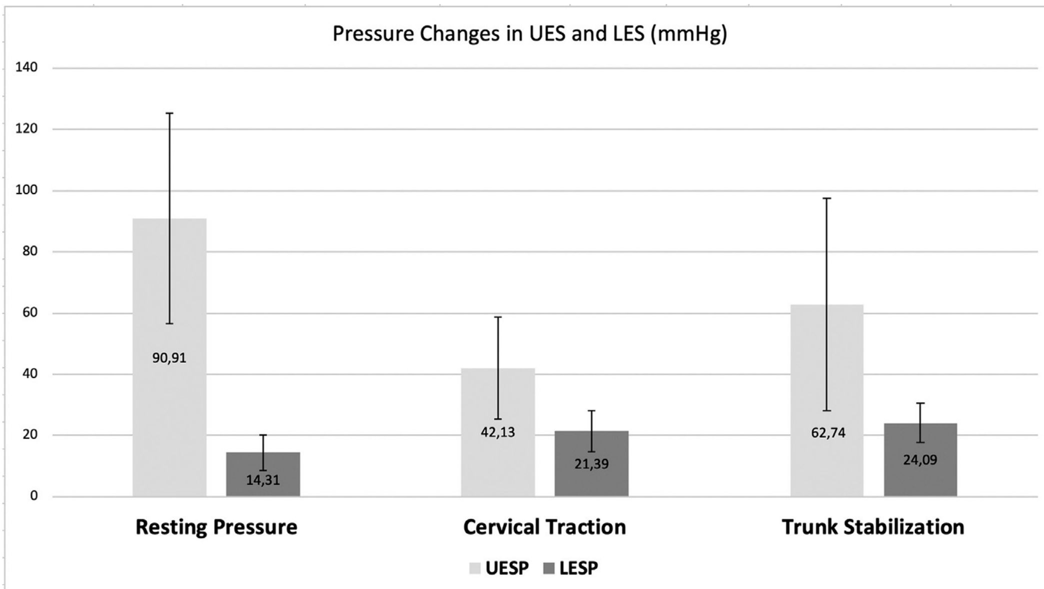

Fig 3. *Statistical overview of all measured pressures.*

LESP. Both techniques decreased UESP and increased LESP. In a clinical setting, however, cervical traction may perhaps provide greater relevance for the UESP, owing to the greater effect size (0.88) compared with trunk stabilization. For the LESP, the trunk stabilization maneuver may provide greater clinical application owing to its effect size (0.98) compared with cervical traction. This fact may be important for the management of common signs of gastroesophageal dysfunction. Routine treatment often starts with an empiric trial of medication, such as proton pump inhibitor therapy for GERD symptoms[31] but also for globus sensation, because a close relationship between esophageal acid reflux and globus sensation has been reported.[32] In case of structural absence, globus sensation may also be considered of a psychological origin and antidepressants or antianxiety medications are often prescribed.[32-34] Such medication may have negative side effects.[6] Lifestyle and or psychological interventions and electrical stimulation of the LES [31] have also been used in treatment. Additional treatment options include more invasive and costly methods including endoscopic and surgical procedures.[35,36]

The UES protects the aerodigestive tract from the effect of digestive juices and aerosol, while regulating belching. Its incompetence results in supraesophageal reflux[37] while increased pressure[38] or failure of relaxation[36] may cause oropharyngeal dysphagia and globus sensation. The UES tone is responsive to body posture, esophageal content, and volume.[39] Babaei et al.[39] reported in healthy populations both liquid and air induces UES contraction in a supine posture, while in the upright posture air-induced UES relaxation occurs. According to Williams et al.,[40] most esophagopharyngeal acid regurgitation occurs abruptly and in the upright position.

Similarly, the LES is responsible for maintaining basal pressure at the esophagogastric junction, forming a critical anti-reflux barrier.[41] The diaphragm acts as an external lower esophageal sphincter that influences pressure, based on respiration. Increased pressure occurs during inspiration owing to contraction of the diaphragmatic crura that involves the sphincter.[42] During swallowing or belching, the LES muscle must relax. Prolonged LES relaxation or incompetence may be accompanied by reflux of gastric contents causing GERD.[43] Reflux symptoms are reported to be posture dependent and patients are advised to sleep with their head elevated, lying on the left side,[23] or use a positional therapy device to reduce nocturnal gastroesophageal reflux symptoms.[44]

Additionally, the functions of the UES and LES are interrelated. In patients with GERD with regurgitation, the UES response to liquid esophageal distention is altered and their esophago-UES contractile reflex is not as robust compared to healthy individuals.[39] Gastroesophageal reflux disease could be the major cause of globus, that is, persistent or intermittent nonpainful sensation of a lump or foreign body in the throat.[33]

Regular and mild-moderate physical activity has been shown to reduce symptoms of GERD, whereas excessive physical activity is a significant risk factor for the development of reflux.[23] Because the diaphragm, which is the main respiratory muscle, plays an important role in the LES, breath training is often advised to treat GERD symptoms.[7,10,11] Respiratory physiotherapy for GERD is discussed even in infants and small children populations.[45] It is important to realize that the diaphragm plays a fundamental role in breathing, postural, and sphincter functions.[46] In this study, we positioned the patient's thorax into neutral alignment as defined by developmental kinesiology and Dynamic Neuromuscular Stabilization concepts.[28,47] The crural part of the diaphragm may be deconditioned or insufficient in individuals with GERD,[20] and its training may help in GERD symptom treatment.[8] An optimal alignment of the rib cage bringing the lower thoracic aperture into a parallel position with the pelvis while lengthening the spine via cervical traction stimulates abdominal breathing, which proved to be effective in increasing LESP.[10] It appears this may have improved the diaphragm's ability to function as an anti-reflux barrier, while regulating LESP as needed.

We also examined the UESP reaction to the 2 manual procedures. The elevated UESP and higher residual pressures during the period of UES relaxation is often associated with globus sensation,[48] which is a common clinical condition that may be long lasting and difficult to treat, has a tendency to recur,[33] and may be related to GERD.[33,48] Both cervical traction and the trunk stabilization maneuvers significantly decreased UESP. This may result from the fact that manual cervical traction reduces alpha-motoneuron excitability,[49] that is, causes muscle relaxation.

Based on the results of this study, we can speculate that both manual procedures may potentially be used in treatment of patients with globus, GERD, and other increased UESP-related symptoms such as dysphagia. This would support a previously published study demonstrating positive effects of osteopathic visceral treatment on GERD symptoms.[9] Further studies are needed to confirm the effect of cervical manual traction and trunk stabilization maneuvers on symptoms and quality of life of patients with such gastroesophageal diseases. It is unknown how long these improvements last in patients with GERD. If such treatments are effective, excessive and long-term consumption of medication with extensive side effects could possibly be reduced as well as more invasive and costly treatment procedures. Close cooperation between gastroenterology and rehabilitation specialists maybe of a potential benefit.

In summary, these results demonstrate the potential influence of the musculoskeletal system on the UES and LES and that UESP and LESP are posturally dependent. During the trunk stabilization maneuver, the diaphragm is placed into a more efficient position to fulfill the dual sphincter and respiratory functions. As a result, the LES force increases. A stable trunk position is important for the diaphragm to fully act as a chief inspiratory muscle, which allows for relaxation of auxiliary respiratory neck muscles and UESP can decrease as a result. Patients with GERD are often chest breathers, using auxiliary respiratory muscles to substitute for insufficient diaphragmatic breathing. With such stereotype the thorax migrates cranially with each breath, subjecting the neck muscles to repetitive strain, possibly creating neck pain commonly associated with GERD symptoms.[50]

Limitations

Besides general technical HRM limitations,[51] the results of this study should be considered in light of some specific limitations. All measurements were done on a convenience sample of patients diagnosed with GERD. It is unknown whether these maneuvers would have the same effect in patients who are asymptomatic of GERD conditions, and further research is required to reproduce and confirm the effect of cervical traction and trunk stabilization maneuver on UESP and LESP in other population samples. Also, only immediate UESP and LESP response to the 2 manual procedures was measured. It remains unknown if the interventions would have any longer effect. Also, further studies need to confirm whether the manual techniques used would be effective in treatment of GERD, globus sensation, or any other gastroesophageal symptoms related to abnormal UESP and LESP regulation and if self-treatment promoting cervical traction and trunk stabilization would be effective. All patients were instructed not to take any medication 24 hours before the assessment or for a longer time if necessary.[52] The HRM was always performed on an empty stomach. The type of medication and dosage for each patient were not recorded (prokinetics, proton pump inhibitors or anti-acid, or any other). The influence of medication on the effect of manual interventions should be further explored as well.

Conclusions

This study attempted to identify the contribution of 2 common rehabilitation techniques on pressure changes in the UESP and LESP. In patients diagnosed with GERD, both the cervical traction and trunk stabilization maneuvers showed positive effects on UESP and LESP. Both manual techniques significantly decreased UESP and increased LESP. Manual cervical traction and trunk stabilization maneuvers could possibly be helpful noninvasive treatments for patients with GERD, globus sensation, or any other gastroesophageal symptoms related to abnormal UESP and LESP regulation.

Funding Sources and Conflicts of Interest

This study was funded by the institutional research program Progres Q41 Foundation "Movement without Help." No conflicts of interest were reported for this study.

Contributorship Information

Concept development (provided idea for the research): P. B., P.K.
Design (planned the methods to generate the results): P.B., J.S., K.B.
Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): P.B.
Data collection/processing (responsible for experiments, patient management, organization, or reporting data): P.B., J.S., S.H., K.B.
Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): J.S., S.H., J.A., M.A., A.B.
Literature search (performed the literature search): A.K.
Writing (responsible for writing a substantive part of the manuscript): A.K.
Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): P.K., A.B., A.K.

Practical Applications

- The findings suggest that cervical manual traction, and trunk stabilization maneuver may decrease upper esophageal sphincter pressure (UESP) and increase lower esophageal sphincter pressure (LESP).
- Rehabilitation and manual therapy may be an appropriate part of complex treatment approach to patients with GERD, dysphagia, and other gastroesophageal symptoms related to abnormal UESP and LESP regulation.

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